

Software Design and Productivity (SDP)

NITRD Agencies: NSF, OSD and DoD Service research organizations, NIH, DARPA, NASA, NIST, DOE/NNSA, NOAA

Other Participants: FAA

SDP R&D will lead to fundamental advances in concepts, methods, techniques, and tools for software design, development, and maintenance that can address the widening gap between the needs of Federal agencies and society for usable and dependable software-based systems and the ability to produce them in a timely, predictable, and cost-effective manner. The SDP R&D agenda spans both the engineering components of software creation (e.g., development environments, component technologies, languages, tools, system software) and the economics of software management (e.g., project management, schedule estimation and prediction, testing, document management systems) across diverse domains that include sensor networks, embedded systems, autonomous software, and highly complex, interconnected systems of systems.

President's 2007 Request

Strategic Priorities Underlying This Request

Improved software development methods: The overall cost – in time, money, and labor – of developing, upgrading, and maintaining software is the most difficult problem in IT deployment. Assuring the correct functionality, reliability, and security of products and processes that include software adds costs and delays implementation. SDP R&D focuses on cost-effective methods to solve these problems, which undermine overall advancement of IT capabilities. Priorities include:

- **Frameworks and environments:** Advances that enable agencies to more efficiently develop and certify high-quality software that is critical to Federal agency missions
- **Next-generation software engineering tools and techniques:** New approaches that reduce the cost, risk, and difficulties of software development; increase the reliability, security, interoperability, scalability, and reusability of software components; and enable software validation and verification

Seamless content interoperability: Software capabilities that enable diverse IT systems, software applications, and networks to exchange and use large volumes of data accurately, effectively, and consistently, both among agencies and between government and the private sector (e.g., data sharing by NASA, NOAA, and DOE/SC across the many interacting modules in the Earth System Modeling Framework (ESMF); availability of electronic health records for doctors, hospitals, and others in the health care industry; and DHS information sharing with 50,000 public-safety agencies)

Highlights of Request

Science of Design (SoD): Make creative scientific advances in the design of software-intensive systems through foundational ideas and theories, including approaches from other design fields; produce intellectually rigorous, analytical, formalized, and teachable body of design knowledge from empirical studies – NSF

Biomedical modeling tools: Develop and disseminate tools to enhance computational modeling of biological, biomedical, and behavioral sciences at scales ranging from the molecular to large populations – NSF, NIH

Collaborative research in computational neuroscience: Provide a theoretical foundation and technological approaches for enhancing understanding of nervous system function through analytical and modeling tools that describe, traverse, and integrate different organizational levels and span broad temporal and spatial scales and multiple levels of abstraction – NIH, NSF

Dynamic Data-Driven Applications Systems (DDDAS): Develop ability to dynamically incorporate additional data into executing applications and enable applications to dynamically steer the measurement process, creating new capabilities in a wide range of science and engineering areas – NSF, NIH, NOAA

Software technology transfer: Embedded Systems Consortium for Hybrid and Embedded Research (ESCHER) for transitioning government-sponsored research results into mainstream or commercial use, including through a quality-controlled software repository – DARPA, NSF

Interoperable biology databases: Develop data standards and ensure interoperability of Internet-based databases important to biotechnology, with emphasis on structural biology – DOE/SC, NIH, NIST, NSF

Software producibility: 2006 new start in building, assuring functionality of, managing, and sustaining software, including net-centric and systems of systems – OSD

Common software infrastructure for climate modeling: ESMF collaboration on building high-performance, flexible software infrastructure to increase ease of use, performance, portability, interoperability, and reuse in climate modeling, numerical weather prediction, data assimilation, and other Earth science applications – NASA, NOAA, DOE/SC

Open-source software: Research that enables users to read, modify, and redistribute source code, fostering more efficient development and increased collaboration to improve software quality – NSF, OSD

Planning and Coordination Supporting Request

Software interoperability workshop: To identify barriers to interoperability, centering on challenge problems whose solution requires new interoperability techniques – SDP CG

Large-scale implementation issues: Briefings by Federal IT user agencies with critical requirements for large-scale software applications to identify development issues and software engineering techniques – SDP CG

Software producibility: National Academies study – OSD, NSF

Additional 2006 and 2007 Activities by Agency

NSF: Software design methods; tools for software testing, analysis, and verification; semantics, design, and implementation of programming languages; scalable software architectures; techniques for handling complex combinations of requirements such as meeting real-time constraints and coordinating control in an embedded, failure-prone environment; compiler and runtime techniques for developing and controlling the execution of complex, dynamically changing applications; requirements for the design and construction of successful-by-design information systems; emphasis on interoperability, robustness, reliability, programmer productivity, maintainability, and software-intensive systems

OSD (HPCMPO): Applications software development in areas such as physics-based design, modeling, simulation, testing; institutes on battlespace topics; PET program tools and techniques for benchmarking, remote visualization, debugging and optimization, interactive computing environments for large datasets

NIH: National Centers for Biomedical Computing (NCBCs) to develop, disseminate, and train users of biomedical computing tools and user environments; encourage collaboration between big and small science at NCBCs; create and disseminate curriculum materials to embed quantitative tools in undergraduate biology education; cancer imaging and computational centers; modeling of infectious disease; bioinformatics resource centers for emerging and re-emerging infectious disease; proteomics and protein structure initiatives; interagency opportunities in multiscale modeling in biomedical, biological, and behavioral systems; individual grants in such topics as simulation and informatics, imaging tools

NIST: Integrated design, procurement, and operation through software interoperability; automated generation of test suites for integration standards; digital library of mathematical functions; ontology for mathematical functions; supply chain software interoperability; international testbed for business-to-business solutions; interoperability of databases for bioinformatics, chemical properties, properties of inorganic materials, and neutron research; ontological approaches to automate integration of supply chain systems; Units Mark-up Language; interface standards for manufacturing control systems; product representation scheme for interoperability among computer-aided engineering systems; standards for exchange of instrument data and chemical reference data; ontological methods for representation and exchange of mathematical data

DOE/NNSA: Provide a production-level, computational environment for ASC platforms, encompassing development tools, visualization and data analysis software, and networking and storage capabilities

FAA: Development of secure, dependable software-based systems in a timely, predictable, and cost-effective manner